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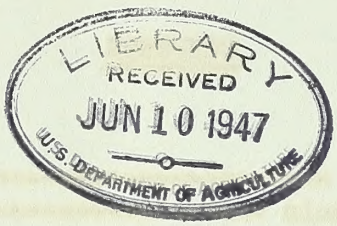

FOREST RESEARCH

BI-MONTHLY REPORT

December 1, 1941

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FOREST ECONOMICS

FOREST SURVEY

Appalachian

Inventory. The inventory tables of forest area and timber volumes have been completed for the entire state of Virginia. A comparison of the Forest Survey findings with the estimates made without the benefit of field cruises in 1932 for the Copeland Report and in 1938 for the Joint Congressional Committee report is given in the following tabulation:

Forest Statistics, Virginia

	Forest Survey (1940)	J.C.C. Report (1938)	Copeland Report (1932)
Total Forest Area (M Acres)	14,832	13,608	
Commercial Forest Area (M Acres)	14,412	13,375	14,857
Sawtimber areas	7,155	6,198	2,859
Under sawlog-size areas	7,257	7,177	11,998
Sawtimber Volumes (Million Bd. Ft.)			
Softwood	12,288	10,960	4,829
Hardwood	12,805	11,190	6,257
Total	25,093	22,150	11,086
Total Volume (Million Cu. Ft.)			
Softwood	4,213	3,857	3,837
Hardwood	6,527	5,469	5,397
Total	10,740	9,326	9,234

It is interesting to note that although the Copeland Report estimates were quite low for sawtimber volumes the cubic foot volumes for all material were very close to the Forest Survey totals. The accuracy of the J.C.C. estimates is attributed to the fact that Forest Survey figures for similar areas in North and South Carolina were available at the time the Virginia estimate was made and were used as guides in determining forest area distribution and volumes per acre.

Drain. During the past two months Carow completed a field canvass of coal mining companies in Virginia, West Virginia, and Kentucky to obtain information regarding the timber requirements of this industry. The 87 companies contacted produce about half of the coal mined in the three states. The survey found that 2,761 sawmills operated in Virginia in 1940 and produced slightly over one billion board feet of lumber.

(Over)

Lake States

Mine Timber Requirements. Mr. White is making a resurvey of timber used in Lake States mines, with special reference to possible shortage during the present national emergency. Since about 83 percent of the iron ore produced in the United States comes from Lake States mines and since ore shipments from this area in 1941 have exceeded by 15 percent the previous all-time peak which was reached in 1916, it might be expected that demands for mine timber would be stretching the productive capacity of forests and logging operations. Although final figures have not been prepared, contacts with mining companies, mine timber brokers, and logging operators in Minnesota indicate that there is no immediate danger of shortages. The chief reason for this is that most of the increased production in Minnesota is coming from open-pit mines.

Even in the open-pit mines, cross-tie requirements are considerably below the former rate because of the recent trend towards use of trucks and conveyors in the place of railroad cars for transporting the ore out of the pits. Thus, the mining companies in Minnesota still have most of the advantages of a buyer's market, although this situation is bound to change some as the general price level for other timber products goes up.

Since the mines purchase most of their timber through brokers and favored logging operators, the smaller operators still face the serious problem of getting satisfactory contracts for mine timbers. The Cooperative Terminal at Duluth, which markets timber products for farmers and small operators, has been unable to get contracts for mine timber from any of the mining companies. Mine timbers, poles, lagging, substandard cross-ties, wedges and mine planking would provide a valuable supplemental market for low-grade sawlogs, tops, dead cedar, tamarack, and even some other species on many logging operations if the buying of these products was only handled on a free and open basis.

The market for mine timber in Michigan, where ore production is primarily from underground mines, is reported to be much more brisk than in Minnesota.

Black Spruce Utilization Study. The Lake States Station has been cooperating with the Minnesota Division of Forestry and the Minnesota and Ontario Paper Company in a study of cutting practices and utilization of black spruce for pulpwood. The purpose of the study is to find out how much additional wood is obtained by utilization beyond the usual 3½-inch top diameter out to 1½ inches in diameter and by cutting 4-foot lengths instead of the usual 8-foot lengths, and to determine cutting time and cost of these different utilization practices. Cutting is now well under way and skidding will start as soon as snow and ground conditions make it possible.

Timber Marketing. As a result of a field study during the summer months, Dickerman has prepared a preliminary report entitled "The Marketing of Forest Products by Small Operators on the Chippewa National Forest". The report indicates that the principal difficulties being encountered by these operators are: (1) lack of information of market prices, of market requirements, and of potential buyers; (2) lack of adequate and economical credit facilities; (3) lack of bargaining power to overcome the ever-present buyers' market; (4) lack of information as to wage-hour law requirements, unemployment taxes and method of securing economical compensation coverage. An analysis of the credit requirements indicated that for the average operator about $300 would be sufficient to finance the stumpage and labor costs and to overcome the difficulties of conducting an operation without adequate credit arrangement. A small group of operators have now organized an informal association and secured a loan from the Farm Security Administration to establish a credit pool. Arrangements for a group compensation policy have been worked out and now all employees of these operators are included under one policy. Methods of overcoming the other difficulties encountered are now being analyzed.

Pacific Northwest

Douglas-Fir Region. In answer to a request from the Portland Chamber of Commerce total timber volume by counties was brought up to date as of January 1, 1941, for western Oregon and western Washington counties through application of depletion and growth data to previous inventories. It is planned to do likewise for eastern Oregon and eastern Washington counties and publish the results.

With the computation of future depletion and periodic net growth rates the revised basic growth calculations for the Grays Harbor unit were completed.

Preliminary analysis of the new growth data collected last summer on 186 sample plots in immature Douglas-fir stands was completed and a report of results prepared.

Extracts From Findings. Analysis of the preliminary data collected from Douglas-fir stands last summer produced the following conclusions:

(1) The temporary plot technique of growth measurement as devised by Girard is capable of rapid and reliable results.

(2) Important improvement in survey growth estimates can be made by use of the system.

(3) Yield table growth correction factors vary by age class as well as stocking class.

(4) A short cut in analysis was effected by correlating growth rates directly with stocking classes as mapped in the field. The less direct alternative previously practiced consisted of three steps: (a) Correlate growth rates with percent of normal stocking, (b) determine stocking (in terms of normal) of the density classes as mapped, and (c) apply the growth rate in (a) indicated by the degree of stocking determined in (b).

(5) The temporary plot technique permits the correlation of growth and mortality with age in greater detail and accuracy than is shown by a normal yield table alone.

(6) Every effort should be made to finish the field work on this project next summer. When completed the findings should have important application in the field of forest management as well as to the survey.

Comparison Assumed Future Depletion and Actual Depletion - Douglas-Fir Region. Eight years' cutting records are now available to check the estimates of future depletion made in 1933 for the decade 1933-42. Generally a satisfactory check was obtained as shown in the following table. The movement to southern Oregon was anticipated but it was not expected to materialize so soon. Undoubtedly, it was accelerated by the defense emergency. The table makes no provision for cutting of minor forest products, year by year records being unavailable. Roughly, 5 billion feet of the total assumed for the 1933-42 decade was attributed to such cutting. This would indicate that actual cutting will exceed assumed cutting by 4.5 to 5.0 billion feet, or about 7 percent.

Comparison Assumed Future Depletion and Actual Depletion
Douglas-Fir Region 1933-42

Districts	Sawlog cutting 1933-40	Sawlog cutting 1940	Estimated cut 1941 and 1942	Probable sawlog cut 1933-42	Assumed future depletion 1933-42
	Million board feet, log scale				
Puget Sound	19,895.4	3,173.8	6,350.0	26,245.4	27,820.0
Grays Harbor	6,611.0	905.8	1,810.0	8,421.0	9,230.0
Columbia River	11,666.6	1,582.8	3,165.0	14,831.6	17,650.0
Willamette River	6,958.2	1,280.0	2,560.0	9,518.2	7,650.0
Oregon Coast	6,272.6	1,161.2	2,330.0	8,602.6	6,650.0
Southern Oregon	1,436.0	296.4	595.0	2,031.0	1,000.0
Total	52,839.8	8,400.0	16,810.0	69,649.8	70,000.0

Southern

Mensuration. In compliance with Mr. Garver's request a computation was made of 1938 net increment by Stover and Snyder, and a study was made by Wheeler of potential growth under good forest management for each State of the Lower South. The results of the two studies are summarized in the following tables:

Table 1.--1938 Net Increment of the Lower South

Timber group	Sawtimber	Under sawlog size timber	All sound timber 5" & above
	M B.F. Int. $\frac{1}{4}$"	M cu.ft.i.b.	M cu.ft. i.b.
Softwoods	9,043,600	317,420	2,167,860
Hardwoods	4,353,800	632,970	1,372,160
Total	13,397,400	950,390	3,540,020

Table 2.--Estimated Potential Growth under Management for the Lower South

Timber group	Sawtimber	Under sawlog size timber	All sound timber 5" & above
	M B.F. Int. $\frac{1}{4}$"	M cu.ft.i.b.	M cu.ft. i.b.
Softwoods	18,007,600	554,480	4,232,500
Hardwoods	12,126,800	1,131,320	3,801,350
Total	30,134,400	1,685,800	8,033,850

Growth. With the completion of the field follow-up of the 1940 Census production, Snyder took over the job of bringing up to date the growth predictions for the states of the lower South. The balance of growth and drain for 1938 was first summarized from the finished computations of the Survey units by individual states and then for the lower South.

Work has commenced on the 1939 growth calculations for the lower South beginning with the states of Georgia, Florida, and Alabama. Naval Stores information that had been formerly summarized by W.P.A. clerks for inclusion in the growth figures was only partly finished at the time the W.P.A. project was closed down. This task has devolved on Miss Nelson who is working up the data needed for adjusting growth figures in the turpentine belt. Preliminary growth computations will continue for the other states until the naval stores data are summarized.

Lake States

Rehabilitation of Minnesota Iron Range. Some interesting and hopeful developments in forest land use are promised by Minnesota's new "Iron Range Resources and Rehabilitation" program. The 1941 legislature earmarked 10 percent of the occupation tax on iron ore for expenditure on this program, whose aim is to develop "other resources" and a new economic base for northern Minnesota counties as an offset to unemployment in the iron ore region. About one-half million dollars annually will be available for development work.

Four advisory committees - forestry, agriculture, mining, and vocational training - have been set up to assist in formulation of policies and review of projects to be undertaken. Moser is a member of the forestry committee and is acting as its secretary. At the request of the Commission of Iron Range Resources, the Station has submitted an outline of worthwhile forestry activities.

Indications are that a major project will take the form of state aid to the counties in the administration of the several million acres of tax-forfeited lands which have come under county control during the past four years. The proposal is modeled along the lines of the federal Clarke-McNary cooperative fire protection program, would require matching funds by the county, and would reserve stabilizing controls in the State. Agriculture and forestry phases of county land administration would be closely integrated under the program and would tie in with rural zoning. Consideration also is being given to a proposal for promotion of forest marketing cooperatives.

Pacific Northwest

Land Planning. Interest in rural land zoning legislation for Oregon continues, new stimulus being given to it by acute land-use problems in suburban areas and along major highways. Heretofore interest has been largely confined to problems in wilderness areas. The hope has been expressed by several that a single enabling measure will be evolved comprehensive enough to permit a broad attack on the several aspects of rural land use susceptible to amelioration by zoning and to obviate fragmentary legislation which calls for frequent overhauling. The most serious difficulty ahead in framing suitable legislation for Oregon is to so design the measure that all local acts under it may be strictly construed as purely administrative since the counties have no legislative powers.

Northeastern

Farm Forestry-Connecticut. Work on the installation of equipment for burning hogged fuel at the Niantic State Farm for Women has come to a stand still after some very rapid progress at the beginning of this period. The inability to secure preference ratings for some of the equipment necessary to complete the installation has been and continues to be an obstacle. All work on excavation, concrete and the installation of the burner itself has been finished. The hog and an outside storage bin are in place and ready for use. In short, everything is set to go with the exception of a conveyor and the motor control. Every effort is being made to secure the necessary preference rating which will permit the purchase of these necessary parts of the equipment.

Official headquarters of the technician in charge of the Fuel Wood Study have been changed from New Haven to Southbridge, Mass. The change has been made so that it is possible to take advantage of the facilities offered by the Quinebaug Forestry Company, a large land owner in the Northeastern part of Connecticut, for the carrying on of fuelwood production time studies, seasoning tests and further investigations of charcoal production. Office space, good equipment, active wood chopping jobs, three newly constructed 90 cord capacity charcoal kilns, and a splendid spirit of cooperation and community service make the transfer a highly satisfactory arrangement for the carrying on of the investigative program.

Southern

Second Annual Extension Forestry Study Day. The second annual meeting, held this year on November 4, was attended by 75 farmers and county agents and by the extension foresters of Arkansas, Mississippi and Louisiana, in addition to state and federal foresters. The aim of the study day is to acquaint farmers and county agents with the income-producing possibilities and methods of management of farm woodlands.

Two 40-acre tracts on the Experimental Forest are set aside as "farm forest forties," and are cut selectively each year. No more volume is removed than the growth during the year. Overmature trees, defective trees, and those likely to die before the next cut are taken out, thereby improving the quality of growing stock and also providing a source of farm cash income. On one such "forty" cut this year, the following products, with stumpage values and values

f.o.b. mill as shown, were removed, equivalent to one year's growth (418 board feet, Doyle, of sawlogs plus 0.44 cords, per acre).

Stumpage value

Logs	12,375 B. F. at $8.77	$108.57
Pulpwood	17.0 cords at $1.00	17.00
Fuel wood	8.0 cords at $0.75	6.00
Posts (post oak)	33 at $0.03	.99
		$132.56
	($3.31 per acre)	

Value f.o.b. mill

Logs	12,375 B. F. at $14.77 ($6.00 per M for cutting and hauling)	$182.82
Pulpwood	17.0 cords at $5.15	87.55
Fuel wood	8.0 cords at $5.00	40.00
Posts	33 at $0.08	2.64
		$313.01
	($7.83 per acre)	

All these products were piled up at the roadside on the "forty" from which they had been cut, as a demonstration of farm forestry possibilities.

RANGE ECONOMICS

Intermountain

The area economic study of the Fishlake and Manti National Forests in central Utah has developed several interesting facts relative to small diversified operating units using the public ranges that bear on the question of distribution.

First, the percent of the gross income secured from range livestock by the small cattle and sheep operations is extremely low. The gross income secured from range cattle for the 1-20 beef cattle operators in this area is only 16 percent; for the 1-100 sheep operators the percentage from range sheep is only 13 percent. The remainder of the gross income is about equally distributed between crop sales and other livestock such as milk cows, poultry, hogs, etc. It is obvious that a substantial reduction or complete elimination of forest grazing

use from these operations would not influence the gross income anywhere near as much as it would the larger operations that secure from 80-90 percent or more of their gross income from livestock.

A second factor that should have an important influence on distribution policy is the amount of outside income secured. The average 1940 AAA payment in the study area was only $35. It is apparent that the payment to small farms would be negligible. However, the 1940 Census shows that 47 percent of the operators in the area secured an average of 121 days work off their farms. Over 75 percent of this was in the form of non-farm work. It can safely be assumed that the great majority of those reporting work off their farms were the small operators. Analysis shows that the farms of the small operators provide only around 200 days of labor, hence the chance for outside employment. Since small farms secure such a substantial part of their income from outside work, it obviously places them in a better income class than if this supplemental income were not secured.

The fact that the small beef and sheep enterprises obtain only 13-16 percent of their gross income from range cattle and sheep, and also secure a considerable amount of income from outside work, places these small operating units in an entirely different position when the question of distribution of public grazing preferences is analyzed.

FOREST TAXATION AND INSURANCE

Southern

Field work in Craig's tax index study in Louisiana was completed in La Salle and Concordia Parishes, but circumstances prevented completion of work in Beauregard and St. Landry. The latter parish has been dropped from the sample because of court action tying up local records and because Craig feels that the two Delta parishes already covered provide an adequate sample of this section of the state. Beauregard Parish will be completed early in December.

All 1941 tax and value data for the nine Alabama counties included in the sample of that state have been compiled into a single table for publication in a forthcoming Occasional Paper, "Taxes on forest property in eight selected parishes of Louisiana, 1937-40, and in nine selected counties of Alabama, 1938-41," which it is hoped to release in January.

The difficulties encountered in some of the parishes first studied in arriving at valid assessed value figures by condition classes (see Bi-monthly report dated October 1) have not been encountered in parishes subsequently studied. Nevertheless, there are great differences among the parishes in the interpretation of what is included under each of the eight possible statutory classifications of forest land, as well as in the relation of actual forest stand conditions to the classification set up on local tax rolls for a given property.

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

Appalachian

Fire Control. Reports on tests of the haze cutter in Regions 1, 5, and 6, during the latter half of the summer are now in. The fire season was in general so mild that the tests were inconclusive. All but one of the 14 lookout men who used the instruments, however, stated that a further test would be desirable. Not only does the filter provide quicker and surer detection of smoke under certain conditions, but it was found that it assists materially in accurately locating a fire because topography and landmarks appear sharper when viewed through the haze cutter. The filters are to be tried in the East and South during the winter and spring fire seasons, after which they will be returned to the West for final field tests.

From time to time in past reports, workers have commented on the difficulties of keeping hygrothermographs properly calibrated, a highly important consideration when humidity at several stations is to be compared. We have found it necessary to adopt a different system in determining the humidity traces at several mountain-side stations. This system is based on the fact that dewpoint temperature in the southern Appalachians does not change rapidly from spot to spot, from one elevation to another, or from day to night, except when a new air mass moves into the region. Accurate temperature tracings must be obtained at each station and a morning and evening psychrometer reading taken at a control station. From dewpoint temperature for the day (control station) and bi-hourly air temperature at mountain-side stations (from the tracings), relative humidity traces can be constructed. An alignment chart simplifies the process and accurate humidity charts result.

California

It has been determined that humidity of the air plays an important part in the rooting of pine cuttings. A new series of rooting experiments has been started at the Institute of Forest Genetics under a "fog" of water mist produced by fine sprays.

Some experimental work was done during the summer which gives promise for developing simple biochemical tests to differentiate pine species. The experiment started with the problem of differentiating Pinus ponderosa from P. Jeffreyi, the latter being considered by some botanists as a variety of P. ponderosa. The technique is based on the fact that Jeffrey pine oleoresin contains minute amounts of aldehydes which, after one or two minutes of shaking with Schiff's reagent (Rosaniline in sulfurous acid) produced a purple color. Ponderosa pine deoresin develops purple color only after prolonged standing which is due not to the original presence of aldehydes but rather to the oxidation of terpene alcohols to the aldehydes. Digger pine oleoresin responds to Schiff's reagent even more vigorously than Jeffrey pine. Of interest is the fact that oleoresin obtained from an artificial cross between Jeffrey and ponderosa pine also gave a positive reaction with Schiff's reagent in two minutes. Owing to the difference in terpene composition of the pines (other than Jeffrey and Digger pine, which do not contain terpenes, but n-heptane with small admixture of aldehydes) it appears feasible to develop also some means of differentiating between the turpentine pines.

Northeastern

Breeding. Hybridization between Acer rubrum and A. saccharinum in the spring of 1941 was very successful from the standpoint of seedlings produced. The hybrid seed gave excellent germination and well over 1,000 hybrid seedlings were living in the fall of 1941.

Second-generation breeding with the Oxford hybrid poplar has also resulted in several hundred seedlings. Some of these seedlings represent hybrids involving 4, 5, or 6 poplar species.

Information gained in preliminary storage tests with pine pollen has been applied in maintaining viability of pollen of other forest species. In the spring of 1940 pollen left over after some exploratory breeding in the genus Picea was stored at 4° C. and 50 percent relative humidity. After 18 months under these conditions pollen of Picea glauca and P. orientalis is still germinable (95 and 81 percent respectively).

Humidity in the storage containers has been maintained with aqueous solutions of sulphuric acid - a satisfactory laboratory method, but one hardly suitable for shipping or field use. Tests with pine pollen have shown that satisfactory humidity may be maintained in shipping bottles if the acid is absorbed in a plug of glass wool. In this way spilling and splashing are obviated, and long-distance shipments of short-lived pollen should be facilitated.

Physiology. Preliminary studies of the voltage gradient relationships in forest trees have indicated a wide range of possibilities for the application of this tool in silvical investigations. To forest genetics problems particularly, there appears to be a direct relationship of the magnitude of voltage gradients to the stage of flower development. This relationship may be useful in determining the period of receptivity for those tree flowers that give little external evidence of this condition, such as oak and hickory. Voltage gradient changes can also be used in predicting phenological events such as bud bursting, leaf development, and growth periods. Fundamentally, voltage gradients reflect internal changes in physiological activity before these can be detected by the usual external examinations.

MENSURATION

Allegheny

Stand Studies. Rapid growth of loblolly pine on the Eastern Shore of Maryland is indicated by the growth analysis of three old sample plots. These stands are adjacent and originated on old fields withdrawn from cultivation in 1900, so the age is the same as the year. Plot 40, farther from the seed source and consequently less densely stocked, is a small plot (1/10-acre) and has border influence on one side due to a drainage ditch and a strip cleared 5 feet wide in 1915. Plots 38 and 39 were overstocked, and 39 was given a thinning in 1926 in an attempt to stimulate growth. The latter was badly stagnated but is recovering as a result of the thinning. Plot 40 was cut over between 1935 and 1940, but definitely shows the advantage of room for early crown development. Data on an acre basis are as follows:

P L O T

Number of trees		38		39		40	
per acre	1906	14,984		13,452		6,140	
Diameter range in inches	1940	4 - 13		4 - 11		6 - 15	
		Volume	Growth per yr.	Volume	Growth per yr.	Volume	Growth per yr.
Volume & growth	1915	292		240		2,240	
Bd. ft. per	1920	1,830	308	1,488	248	6,980	950
acre per	1925	5,630	760	3,896	480	14,600	1,320
year. Mt.	1930	8,700	624	6,020	424	20,500	1,180
1/4" Kerf	1935	12,440	748	8,840	564	28,180	1,540
to 5" top	1940	16,060	724	11,840	600	22,260	533

Lake States

Tree Classification. Bates and Stott of the Regional Office have developed a scheme of tree classes based on lumber grade recovery (as determined by a mill-scale study) and an estimate of vigor. The Station's scheme, proposed by Gevorkiantz and modified by Zehngraff, is a complete catalog of all the characteristics of the tree, as follows:

A. Capacity for growth
   I. Position (7 classes)
   II. Possibility of future crown development (5 classes)

B. Quality and risk
   III. Soundness (3 degrees)
   IV. Form (3 classes)

C. Present worth
   V. Value (based on number and quality of logs)

Since the Station has a number of plots that have 10- and 15-year tree records, an excellent opportunity was presented to apply both classification schemes to see how they check with known growth. Although the data have not all been analyzed it appears as though this application would result in the injection of a better definition of vigor into the State and Private Forestry classification and some simplification of the scheme proposed by the Station.

Pacific Northwest

Growth - Even-Aged Spruce-Hemlock. A progress report giving detailed remeasurement statistics for the 11 permanent sample plots in spruce-hemlock at Cascade Head Experimental Forest was completed. From age 83 to 89 years the average stand per acre on these plots increased from 119,190 to 129,740 board feet, Scribner rule, indicating an annual net growth of 1,758 board feet per acre for the period, and a mean annual increment of 1,458 board feet per acre to age 89 years.

Rocky Mountain

Tree studies - lodgepole pine. The question as to whether volume tables constructed from measurements of trees in virgin stands are applicable to cut-over stands of the same species in the same region and vice versa is often raised. Volume tables recently constructed by the regression equation method for both virgin and cut-over stands of lodgepole pine in Colorado and Wyoming provided an excellent opportunity for making such a test.

The volume equation for virgin stands was based on the measurements of 506 trees while that for cut-over stands was based upon 264 tree measurements. The two equations are:

$$\text{Virgin stands } \bar{X}_1 = 1.0573X_2 + 1.3678X_3 - 1.1454$$

$$\text{Cut-over stands } \bar{X}_1 = 1.1732X_2 + 1.1291X_3 - 0.7915$$

where:

$\bar{X}_1$ = log (volume - 7) in board feet

X_2 = log (d.b.h. - 8) in inches

X_3 = log (height - 4.5) in feet

Comparison of the volume equations resolves itself into a test of the significance of the difference in the log (volume - 7) of individual trees of a given diameter and height, as estimated by the two volume equations. This test was accomplished through the use of the standard error of the function, i.e., of the regression equation.

With the logarithmic equations as the functions and twice the standard error of the difference between values as calculated by two functions for trees of the same size as the lower limit of significance,

tests were made for 31 combinations throughout the most commonly used range of d.b.h. and height. Although the volume tables constructed from these equations indicated small differences in volumes for trees of the same size, not once in the 31 combinations tested did the ratio of the difference to the standard error of the difference exceed 0.29.

This test indicated that the small differences in volume given by the volume equations were most probably the result of errors of sampling a homogeneous population and not likely as a result of differences in form between the virgin and cut-over stands. In this instance the volume table made for one type of stand is equally applicable to the other.

REGENERATION

Central States

Seed Spotting of Shortleaf Pine. The study of seed spotting of shortleaf pine in blackjack oak stands in the Missouri Ozarks to test the possibilities of using direct seeding of pine to supplement or replace the more costly practice of planting was expanded this fall. The new phase of the study is designed to test the effects of 4 times of seeding under 2 types of release on germination and seedling establishment, survival, and growth. The 4 times of seeding are: (1) November, (2) January, (3) March, and (4) a duplicate in March using stratified seed. The 2 types of release are: (1) clear cutting, and (2) girdling. One set of plots is to be seeded during the 1941-42 dormant season and another during the 1942-43 dormant season. The releases are to be made early in the dormant season in which the seeding is done. The rows of seed spots are to extend across the isolation strip in order to ascertain to what distance the overstory trees affect the establishment, survival, and growth of the seedlings.

Lake States

Hardwood Seeding in Wisconsin. Seeding of valuable hardwoods such as yellow birch, basswood, sugar maple, white ash, and red oak has not received much emphasis in experimental work in the hardwood region of the Lake States. To supplement the data now available, four plots were laid out in fall 1940 on the Nicolet Forest to compare: fall versus spring seeding, different species seeded pure and in mixture, furrowing and disking as a means of ground preparation, and direct seeding with planting of nursery-grown seedlings.

Ground preparation in plowed areas was accomplished with the standard Killifer planting plow, while the disking was done with a heavy 8-foot Moline disk. Experience with the 8-foot disk indicated that this is too wide a machine where stumps or large trees are present at a fairly close spacing. Such impediments cause frequent "hanging up" of the equipment. The next piece of equipment to be tested will be the cut-down version of the Athens disk used on the Chippewa Forest. This equipment has 4 disks and an overall width of about 5 feet, or just the width of a medium-sized tractor.

The approach to the problem of hardwood seeding and planting in Wisconsin is based on certain premises and observations, chief of which is the fact that on the better soils (sandy loams to silt loams) hardwoods are naturally very aggressive and take over such sites, providing seed trees are present and a good seed-bed condition (chiefly an absence of sod) has been obtained by the shading effect of an overstory. Where seed trees of hardwoods are present, aspen areas on good soils tend naturally to convert to valuable hardwoods. On areas where seed trees are not present, the question arises: Why spend $20 to $40 per acre trying to convert such areas to pine when half that amount might establish a valuable crop of hardwoods by planting or seeding?

One of the big items of expense in conversion of aspen to pine lies in the repeated releases necessary to bring through the pine. Most of the hardwoods used in the Wisconsin experiments are quite tolerant and it is believed that if they were seeded under aspen, they would come through without release until the overstory of aspen could be clear-cut for pulpwood at an age of 35 to 45 years.

More on Germination Temperatures. That species which occur over a wide geographic range may show variable germination behavior is suggested by the results obtained with recent tests of Prunus americana seed. Earlier tests of seed from the Chippewa had indicated that the best germination of properly after-ripened seed occurred at a temperature of about 50° F. However, at the suggestion of Nurseryman Taylor of the Prairie States Forestry Project who, on the basis of his own tests, was somewhat skeptical of our results, Roe ran a test of Nebraska seed consisting of one lot which had been stratified by Mr. Taylor and one lot stratified here, and found that both lots showed the best germination at temperatures alternating from 50° F. at night to 77° F. during the day, with alternations of 68 to 86° F. a close second, 50° F. third, and 41° F. poorest. Apparently seed from northern sources behaved differently from that from the southern part of the range.

Also of possible interest was the discovery that the climbing bittersweet (Celastrus scandens), hitherto a poor germinator in our laboratory even after stratification, gives excellent germination at alternations of 50° to 77° F.

Northern Rocky Mountain

Summary of Direct Seeding Tests. Experimental work in direct seeding by the Northern Rocky Mountain Station since 1937 has provided sufficient data to warrant limited application of seeding by the administrative organization. Using methods worked out in experimental installations, administrative projects with CCC labor have included one 97-acre western white pine seeding on the Coeur d' Alene Forest and one 40-acre ponderosa pine seeding on the Nezperce Forest established in October 1940 and one 40-acre ponderosa pine seeding on the Kootenai Forest in October 1941. Additional seedings would have been made in 1941 if there had been sufficient labor.

The basis for administrative application was the results of nine western white pine and four ponderosa pine experimental seedings which demonstrated that:

1. Successful seeding of western white pine and ponderosa pine was possible on selected good sites if seed-eating rodents were controlled.

2. Rodent control was effectively secured with conical wire screens. If left in place during the first growing season, screens also had the advantages of providing partial shade and protection from erosion and animal browsing and conserving soil moisture.

3. Satisfactory rodent control using a poisoning method developed by the Wildlife Research Laboratory of the Fish and Wildlife Service was found to be cheaper and more practical than screens.

4. Fall sowing was superior to spring sowing.

5. Cultivation of the ground prior to sowing on recent burns had no effect on germination and survival.

6. Sowing in prepared spots was cheaper than broadcast sowing with both methods giving about the same stocking.

7. Spot seeding on one 50-acre site was done for 71 percent of the average regional planting cost.

8. Rodent control using only hulled sunflower seed treated with thallium sulfate as a bait a week or two in advance of seeding seemed to be equally as effective as baiting followed by seeding with poison-coated pine seeds, the method originally recommended by the Fish and Wildlife Service.

Germination was satisfactory on both the 1940 large-scale seedings, which used the poisoning method of rodent control recommended by the Fish and Wildlife Service, but survival at the end of the first growing season was satisfactory on only the white pine area. Unsatisfactory stocking on the ponderosa pine seeding was believed to be the result of damage to the seedlings by unusually large numbers of grasshoppers which invaded the area. Normally when grasshoppers are not excessive, the poisoning method should permit successful germination and survival on selected sites. Cost of white pine seeding on the Coeur d'Alene Forest was $9.83 per acre, 54 percent of the cost of planting white pine on the same forest in 1940.

Experimental work has also been done in direct seeding with western redcedar, Engelmann spruce, and Douglas-fir which points the way toward restricted seeding of these species on selected sites, but as yet no practical application has been made. Eleven tests with western redcedar, four tests with Engelmann spruce, and one with Douglas-fir disclosed that:

1. Protection from rodents was not necessary for successful seeding of western redcedar and Engelmann spruce on the sites involved. These two species have small seeds which apparently are not very attractive to rodents. Although germination and survival were slightly better under screens, unprotected Engelmann spruce seeds gave satisfactory stocking.

2. Rodent control was necessary for satisfactory germination of Douglas-fir.

3. Fall sowing produced better results than spring sowing with western redcedar and Engelmann spruce. No spring sowings were made with Douglas-fir.

4. Cultivation of the ground prior to sowing had no effect on germination and survival of Engelmann spruce.

5. Germination and survival of western redcedar on several exposures and under various canopies showed that site, exposure, and vegetative conditions under which redcedar can be seeded are rather limited. The extent of the limitation has not yet been fully determined.

6. Sowing of Douglas-fir in prepared spots was cheaper than broadcast sowing.

Southwestern

Cork Oak Planting. With imports of cork from the Mediterranean threatened by the European war, considerable interest has developed in the possibilities of growing cork oak domestically. It is recognized that plantations established now will not come into production during the present crisis. It is also recognized that if and when free international trade is restored, cork grown in plantations will probably not be able to compete commercially with cork grown in the native forests of Europe and harvested with cheap labor. It nevertheless seems desirable in the interests of national economic independence to grow sufficient cork to supply our defense needs during periods of national emergency. Before large-scale planting operations are started, however, there is need for considerable research to determine: (1) the areas most suitable for growing cork oak, (2) the most economical methods for successfully establishing plantations, and (3) the conditions under which cork production in plantations will be a profitable enterprise.

Scattered cork oaks growing as ornamentals in California, Arizona, and Texas, and two plantations in California have indicated that conditions are favorable for cork oak in the southwestern portion of the United States, if trees are given adequate care. There are, moreover, in California, Arizona, New Mexico, and Texas extensive areas of evergreen oaks which, though of different species, are ecologically very similar to the European cork oak forests. Recent stripping tests have indicated that the virgin cork from California trees is equal in all respects to imported cork of the same grade.

Valuable information on the propagation and care of cork oak has been assembled by the Extension Forester of the University of California, who, in cooperation with one of the cork companies, is sponsoring a planting program among the farmers of that State. It is felt that, in addition to trials on agricultural sites, test plantings should also be made in the native evergreen oak forests, where land values are relatively low, and where large areas, if needed, could be devoted to cork production.

With this latter phase in mind, plans have been completed for initiating a few studies on cork oak this winter, centering the work at the Parker Creek Station, which is located in one of the best native oak types in central Arizona. One of the first steps will be the establishment of a 2-acre plantation on one of the best sites. This will contain stock from several sources and planting will be by the best methods known at present. An exploratory study will

also be conducted to determine for several representative sites the most promising methods for establishing cork oak trees in native evergreen oak stands. Treatments to be tested include: (1) planting of seedlings propagated in a nursery, (2) planting of sprouted acorns directly in the field, (3) removal of oak overstory, (4) protection from livestock and rodents, and (5) watering during dry months.

SILVICULTURE

Allegheny

Stand Improvement. Measurement of eight acres of plots involving 2826 trees has shown conclusively that thinning in a 40 year old stand increased by 14 percent the number of trees severely damaged by ice storms. In these thinnings 25 to 35 percent of the original volume was removed. Black cherry, and to a lesser extent, beech were most susceptible by reasons of their large, limby crowns which often project above the general level of the canopy. In order to realize the benefits from partial cuttings and at the same time reduce the possibility of serious glaze damage, two courses of action are advisable: (1) thin as lightly as economically possible, taking the largest, limbiest trees; (2) favor sugar-maple and hemlock, especially at high elevations and on northern aspects subject to glaze.

Measurement of two thinned stands of sugar maple and black cherry showed a marked contrast between the results of light and heavy thinnings. Where 40 of the largest black cherry had been removed, sufficient light was admitted to the stand that the stumps sprouted vigorously, and 116 seedlings and seedling sprouts became established. The increase in number of sprout stems with their greater susceptibility to rot reduces the value of the stand for saw timber production. Where only 24 trees per acre were removed, the residual sugar maple took over to such an extent that no cherry sprouts survived to join the canopy.

The establishment of 40 sample plots and temporary check areas on Atlantic white-cedar sites in southern New Jersey has been virtually completed. The main phase of this study investigates the feasibility of converting swamp borders and hardwood swamps to white-cedar by means of both planting and direct seeding accompanied by several treatments of soil, brush, and overwood. In addition, six plots are concerned with determining the most effective T.S.I. practices for three different sites. Seed traps are being used to study seed dispersal from seed trees and clumps. Two plots will yield information on the importance of browsing by deer

in retarding the development of reproduction stands. For the most part no results of consequence will be apparent for three to five years, although seed dispersal data will be added to every year, and observation of the other phases from time to time will yield information of use in planning State reforestation and T.S.I. programs.

Appalachian

Pruning of Eastern White Pine. Experimental live pruning of eastern white pine in Union County, Georgia, indicates that a considerable portion of the living crown can be removed without seriously reducing diameter or height growth.

White pine ranging from 16 to 20 years of age, from 2 to 7 inches in diameter at breast height, and from 15 to 48 feet high were used in the experiment, 94 trees being treated in each of the four ways listed below:

1. Check trees - no pruning.
2. Light pruning - 6 to 15 percent of the living branch whorls removed.
3. Moderate pruning - 16 to 25 percent of the living branch whorls removed.
4. Heavy pruning - 26 to 35 percent of the living branch whorls removed.

The average growth per tree, for the total of five growing seasons, for each of the four treatments, is given below. The figures have been adjusted to allow for differences in diameter, height, and crown ratio between the trees at the beginning of the experiment.

Kind of pruning	Average growth for total of five growing seasons	
	Diameter (Inches)	Height (Feet)
None (check)	1.28	9.0
Light	1.28	9.1
Moderate	1.24	9.1
Heavy	1.18	8.7

Although an analysis of growth two years after pruning showed that diameter growth of heavily pruned trees was significantly less than those under other treatments, an analysis of growth for five

years after pruning showed no significant differences between any of the treatments. Thus, 16 to 25 percent of the living whorls may be removed without decreasing diameter or height growth; and in view of the high value of clear lumber it may be worth while to prune 26 to 35 percent of the living whorls and disregard the slight decrease in growth that may result.

1941 Another Poor Seed Year For Oaks. Indications are that the acorn crop for 1941 is the lowest in the six years since the acorn production study was started on the Bent Creek and Toccoa Experimental Forests. On the Toccoa Forest in North Georgia particularly, the crop is almost a total failure for all five of the species included in the study (white, black, scarlet, northern red, and chestnut oaks); on the Bent Creek forest near Asheville, the crop is generally very light, with black oak and northern red oak bearing somewhat heavier than the other species. Of the six years during which acorn collections have been made, four years have been marked by light crops and two years, 1936 and 1938, were years of fair to heavy production. There is a general, but far from close agreement in production between species from year to year, and between the two experimental forests. However, there may be much variation within a species from one locality to another. This has been observed this year, particularly for chestnut oak, and to a lesser extent for northern red oak on the Pisgah National Forest near Asheville.

California

Sale area improvement. A major problem in the management of ponderosa and sugar pine sale areas is the retention of control of the soil after logging until reproduction becomes established. Infrequent pine seed crops, foraging rodents, encroaching brush, and heavy mortality of seedlings contribute to sale area deterioration. Past observations have shown the infrequency with which ponderosa or sugar pine seedlings become established in areas controlled by brush.

The occurrence of a prodigious crop of sugar pine cones in 1941 offered an opportunity to try site preparation in advance of seed fall in areas lost to brush. Plots were selected in areas with seed bearing sugar pine trees where the ground was dominated by brush of two types, Ceanothus cordulatus and Chamaebatia foliolosa, to test the feasibility of site preparation as an aid to natural regeneration and to compare the effectiveness of natural seeding with planting and seed spotting.

The plots, numbering 20 in the Ceanothus type and 17 in the Chamaebatia, were cleared with a D-2 tractor equipped with a brush

rake designed by the Office of Blister Rust Control, Bureau of Entomology and Plant Quarantine. Portions of the 24 feet square plots were (1) reserved for observation of natural reproduction, (2) planted with 1-1 sugar pines, (3) planted with seedspots, protected by rodent screens, and (4) used to measure seed fall by traps. The positions of the three methods of regeneration and of the seed traps were located randomly within the sample plot.

Examination of the seed traps in the stripped areas indicated a general fall of sugar pine seed. Only one stripped plot showed no sugar pine seed in the traps. The average number of seeds per trap was 2.2; a significant difference existed between plots in the number of seeds per trap.

Future examination will include periodic counts of germinations and survival of seedlings in the natural quadrants and in the seedspots, and observation on the survival of the planted stock. In addition germination and survival of sugar pine seedlings will be observed on plots adjoining the stripped areas. Annual examinations of the surviving seedlings and planted trees will be made after the first year and the reinvasion by the brush measured.

Intermountain

Natural restocking of ponderosa pine. Observations of ponderosa pine seed dissemination, germination, and seedling survival on an area burned over in 1934 near Idaho City in southern Idaho tentatively show that fully stocking of seedlings occurred to a distance of only 70 feet from a timber front seed source at the end of the 1941 growing season. The data were obtained on seed trap lines and reproduction transects run in the four cardinal directions from an isolated body of green timber within a burned-over area of several thousand acres and from an isolated live tree several miles from the block of green timber within the same burned area. From the block of green timber, the transects traversed areas of all general aspects, while on the single tree area the slope was predominately south facing.

General observations indicate that crops of ponderosa pine seedlings sufficient for adequate restocking of denuded areas occur only when an unusually good seed crop is followed by an unusually wet growing season. This sequence has apparently occured in the Idaho City area only twice during the last 40 years. The current study, however, indicates that the excellent cone crop of 1940 and the favorable distribution of precipitation during the 1941 growing season will make another such sequence. Hence the current study

provides a rare opportunity to observe the distance from a seed source that natural seeding is effective in restocking a denuded area.

For full restocking of a denuded area an estimated 2,000 one-year-old seedlings per acre appears to be the necessary minimum. Assuming that this figure is correct, full restocking occurred only a distance of about 70 feet from the timber front seed source of this study as indicated by an interpolation of the seedling survival data in the following table. The occasional seedlings that may become established during the next few years may bring the area up to full stocking for a distance of perhaps 100 feet with half-normal stocking out to perhaps 250 feet. Occasional seedlings survived at distances out to 500 feet but their numbers are negligible.

The severe conditions for the establishment of seedlings on this area even during the favorable year 1941 are shown by the fact that out of all the seeds falling on the area, 56 percent were sound seed, 1.4 percent germinated, and 0.9 percent produced seedlings that survived the first growing season. Of the seedlings resulting from germination however, 65 percent survived the first growing season. Hence the greatest obstacles appear to be in the lack of spots suitable for germination that seeds may fall upon and the destruction of seeds by rodents.

Table 1.--Natural regeneration of ponderosa pine on a 7-year-old burn in 1941.

Distance from seed source	Timber front seed source				Single tree seed source			
	Seed dissemination		Germination of seeds	1st year survival of seedlings	Seed dissemination		Germination of seeds	1st year survival of seedlings
	Total seed	Sound seed			Total seed	Sound seed		
Feet	Number per milacre				Number per milacre			
0	801	400	7.8	4.6	-	-	-	-
25	-	-	-	-	266	80	1.1	0.5
50	143	127	3.3	2.5	83	32	1.4	0.7
100	68	42	2.1	1.4	35	18	1.2	0.9
200	19	12	1.6	1.2	13	8	0.8	0.5
300	8	4	-	-	3	2	-	-
400	10	4	-	-	2	2	-	-
500	15	4	-	-	-	-	-	-
Totals	1,064	593	14.8	9.7	402	142	4.5	2.6

Lake States

Partial Cutting in Black Spruce. An experimental partial cutting in swamp black spruce, made in 1935 at the Superior branch station, was remeasured last summer, and the data have been summarized. The results are of considerable interest because partial cutting of swamp spruce is rapidly becoming the accepted practice on managed forests in the Lake States, in contrast to the former practice of clear cutting which was justified by some foresters on the basis that black spruce must be cut clear to prevent excessive windfall losses.

On the experimental cutting 10 cords per acre were removed and 11 cords were left. Some mortality from windfall and other causes occurred, but the losses were not serious. During the 6 years following cutting, net growth averaged 0.28 cord per acre per year. This is not an impressive rate of growth, but it means that merchantable cuts of about 5 cords can be removed at 20-year intervals, instead of making a single clear cutting and then getting nothing more from the land for an indefinitely long period, probably 80 or 100 years.

These cuttings were located on a below-average site; well stocked swamps on better sites can be expected to produce substantially greater amounts of timber.

Northeastern

The high prices paid for spruce pulpwood during World War I and for a period thereafter stimulated considerable planting of red, white and Norway spruce through northern New England. Many of these plantations are now from 20 to 25 years of age and in need of silvicultural treatment. Although it is questionable whether pruning of spruce plantations can be justified economically at present, information on the cost and effects of such pruning should ultimately prove of value in the future management of these species. As a basis for obtaining such information a pruning study was initiated at the Gale River Experimental Forest to determine specifically the effects of pruning green branches from red and white spruce, including rate of healing and the effect on the growth rate. Since the experiment was initiated two months ago it is possible only to present figures on the time consumed in pruning operations.

A hundred trees, 75 white spruce averaging 4 inches d.b.h. and 18 feet high and 25 red spruce averaging 6 inches d.b.h. and

20 feet high form the basis of the experiment. In both species live limbs remained practically to the ground. The white spruces were pruned to a height of 7 feet and the red spruces to a height of 8 feet. On no trees pruned were any branches in excess of one inch in diameter at the base. Pruning time is summarized in the following table:

Table 1

Actual Time Consumed in
Pruning White and Red Spruce

Species	Pruner A		Pruner B		Total Pruners A&B	
	No. trees pruned	Av. time in minutes	No. trees pruned	Av. time in minutes	No. trees pruned	Av. time in minutes
White spruce	35	2.4	40	2.8	75	2.6
Red spruce	15	3.3	10	5.5	25	4.2
Total and average	50	2.7	50	3.3	100	3.0

Pruning time shown in the table is restricted to time consumed in actual tree pruning operations, hence does not include time required to move from tree to tree or to select the trees to be pruned. It is believed that the time shown for Pruner B represents close to normal output.

Southwestern

Harvest Cuttings - Ponderosa Pine. Recent compilations have made available stand data on two areas logged during the past summer.

A second cutting on an area of 90 acres logged the first time in 1894 under private control removed 2,750 board feet gross per acre and left 2,005 board feet.

The remaining stand is classified as follows:

D. B. H. class	Trees per acre	Volume per acre
Inches	Number	Ft. b.m.
4-7	63.5	-
8-11	44.4	-
12-19	9.5	936
20+	4.3	1,069
Total	121.7	2,005

Both the cut and the reserved volume were lighter than in the second cut in 1939 of a 30-year-old Forest Service cut-over area. Poles, on the other hand, are more numerous on this area. Aside from a few large openings which have failed to restock because of a deficiency of seed trees, an excellent growing stock is in the making. Stand improvement followed the logging.

An area of 80 acres not previously logged was cut by the improvement selection method. Out of an original volume of 17,494 feet b.m. per acre, by tree measurement, 9,033 feet gross was cut and 8,461 feet left. Distribution by broad diameter classes of the remaining stand is as follows:

D. B. H. class	Trees per acre	Volume per acre
Inches	Number	Ft.b.m.
8-11	4.0	34
12-20	11.7	1,940
21-30	8.0	5,993
31+	0.3	494
Total	24.0	8,461

The bulk of the residual volume is in the 21-30-inch diameter classes, and is made up largely of trees between 150 and 200 years old. They occur in groups occupying about 25 percent of the total area. Although cutting opened up these groups, spacing is still too close for efficient growth.

A second cut is planned about 10 years hence, in order to salvage windfalls, lightning-struck, squirrel-damaged, and other declining trees, at the same time opening the groups further. It is estimated that this cut will remove about 3,000 board feet, 1,000 of which will be increment since the first cut.

Subsequent cuts at 20-year intervals are contemplated. Although a definite program is desirable, it should be flexible enough to permit logging operations following heavy windfall or other major disturbances. Experience indicates that a straight salvage cutting is seldom practical.

Assuming an average cutting cycle of 20 years and a current annual increment of 100 board feet per acre (probably low), each cut can remove 4,000 board feet by taking 2,000 feet of the original reserve. Such a program would remove the bulk of the present mature and intermediate age classes in 50 years, by which time present blackjacks, now mainly below 22 inches d.b.h., will be ready for cutting.

Cutting aims to put the entire stand in growing condition by opening both mature and immature groups, always taking the largest and roughest stems first. Physiologically sound trees with Class C and even Class D crowns will grow rapidly if released. Desirable stems below 17 inches d.b.h. have been pruned to aheight of 17 feet, financed by a K. V. deposit of $1 per M cut. Excellent reproduction in the sapling and small pole stages prevails over the areaand has been subjected to preliminary stand improvement.

The area has been made into a permanent sample plot by tagging and measuring diameter and height of all trees 8 inches d.b.h. and over.

Douglas-fir. Not since silvical investigations were begun in the Douglas-fir type at Cloudcroft in 1931 have conditions for studying natural regeneration been so favorable as they were during the past season. In the fall of 1940 a good seed crop was borne over extensive areas and the following year rains not only started early but were also abundant and well distributed. During the 4 months of June, July, August, and September a total of 26.8 inches fell at Cloudcroft. This is almost equivalent to the average total annual precipitation. Air and surface soil temperatures were also lower than usual during this period. By and large it may be said that so far as physical factors are concerned these were extremely favorable for both seed germination and seedling survival. Obviously under such conditions the differences in results obtained on the various study areas would be ascribable to other factors. The results based on seedling samplings made last fall have, in fact, confirmed what the results from artificial sowings made in previous years had already indicated; namely, that rodents, mostly mice, are chiefly responsible for hindering the restocking of Douglas-fir stands, and that where these rodents are not controlled the benefits of silvicultural measures are largely vitiated.

Krauch visited several other forests in Region 3 during the past summer in order to examine conditions in the Douglas-fir type on these forests, and to discuss problems with the local supervisors.

What would seem to require serious consideration is the spruce budworm (Cacoecia fumiferana) infestation that has spread throughout the Douglas-fir and spruce types on the Santa Fe and Carson National Forests. In some localities practically all age classes have been attacked. Because of the new needles being destroyed year after year, many of the trees have become greatly weakened, which has rendered them susceptible to attack and ultimate destruction by secondary enemies. Aside from the immediate damage to existing stands is the fact that the nature of the budworms' work is such as to effectively prevent seed production. Judging

from the almost total absence of old cones on the forest floor in some of the localities examined, it is evident that there has not been any Douglas-fir seed produced for many years. Obviously, in the absence of seed production natural regeneration of the stands cannot be expected to take place, regardless of how favorable other conditions may be.

Apparently the Santa Fe and Carson National Forests are the only forests in Region 3 in which damage by the spruce budworm has reached alarming proportions. In fact very little damage has thus far occurred in Douglas-fir or spruce stands in the Apache, Crook, or Lincoln forests.

Douglas-fir Areas Increasing. It has long been observed that on the forests in which ponderosa pine grows near or in mixture with Douglas-fir, seedlings of the latter species have not only succeeded in becoming established under the pine but are also usually more abundant and seem to thrive better than those growing on what are usually regarded as true Douglas-fir sites. It is thought that the pine areas now restocking to Douglas-fir do, in reality, represent Douglas-fir site and should be regarded as such as there is every reason to believe that they will in time contain commercial stands of Douglas-fir timber. Assuming that this inference is correct, the area that should be classed as Douglas-fir type is for some of the forests far more extensive than present surveys indicate. This would seem to apply especially to the Apache forest where an excellent understory of Douglas-fir seedlings and saplings occurs over extensive areas now occupied by mature ponderosa pine.

Insects on Pinons. A collection was made of the insects observed on pinons (Pinus edulis Engelm.) in Arizona and New Mexico incidental to research on pinons from 1937 to 1941. The specimens have been forwarded to Washington for determination, and a rough draft of a report of the insects on pinons has been prepared.

The various insects on the foliage are not of great economic importance. These include pine-tip moths, scale insects, aphids, caterpillars, gall makers, cicadas, and ants. Pine-tip moths cause some damage to growth, and scale insects, including pine needle scales (Chionaspis pinifoliae Fitch) and Matsucoccus acalyptus Herbert, kill a few trees.

Of the insects in the bark, the Arizona five-spined engraver or bark beetle (Ips lecontei Sw.) is most destructive. Though generally only a few weakened trees are attacked, numbers of trees are killed over large areas in infrequent epidemics lasting only a year or two.

The insects attacking the cones and seeds of pinons are, of course, those of greatest economic importance, even though they do not kill the trees, because the edible seeds or pinon nuts are the most valuable products. Seed chalcids kill many cones the first year, and caterpillars of cone moths and cone beetles destroy numerous cones and seeds the second year. These insects kill nearly all the cones of a light cone crop and destroy a smaller proportion of a heavy cone crop.

Control measures probably would not be practicable under forest conditions, but it is possible that methods may be developed later for small areas under intensive management for pinon nut production. As insects destroy a very high percentage of the cones when the number of cones is small, some allowances for probable losses should be made every year when advance estimates of the pinon nut crop are made.

FOREST PRODUCTS

FOREST PRODUCTS STATISTICS

Northern Rocky Mountain

The semi-annual revision of the circular covering cross-tie specifications and prices, prepared in the Products Division on October 15, shows that during the preceding 3 or 4 months prices paid by the three transcontinental railroads traversing Region One increased considerably. On October 8, the Chicago, Milwaukee, St. Paul and Pacific Railroad was out of the market but reported that about $18 per M, f.o.b. cars, would be paid for sawed ties when buying was resumed. In April 1941 this railroad was paying $14.50 per M for 7" x 8" - 8' Douglas-fir and larch ties. Reports from purchasing agents of the Great Northern and Northern Pacific Railroads on September 26 and October 14, respectively, listed the following prices:

Dimensions	Great Northern (delivered on right-of-way)		Northern Pacific (f.o.b. cars)
	Reported price per tie	Computed price per M	Reported price per M
	Dollars	Dollars	Dollars
6" x 8" - 8'6"	0.40	11.75	-
6" x 8" - 8'	-	-	14.00
7" x 8" - 8'6"	0.47	11.80	-
7" x 8" - 8'	-	-	14.50
7" x 9" - 8'6"	0.56	12.50	-
7" x 9" - 8'	-	-	15.00

These figures indicate increases ranging from $2.35 to $2.50 per M on the various grades of ties procured by the Great Northern, and $1, $1.50, and $2 per M on the grades 3, 4, and 5 ties purchased by the Northern Pacific within the past few months.

TIMBER HARVESTING AND CONVERSION

Northern Rocky Mountain

In June, the Rudoph Wurlitzer Company of Los Angeles requested assistance in connection with the procurement of Engelmann spruce for experimental use as violin stock. Three sample pieces obtained by Rapraeger were furnished at that time. Diagrams and specifications received with the company's acknowledgement of these samples indicated that for violin-making purposes the wood should be old, from large trees, and close-grained (about 1/20-inch growth rings), seasoned but not artificially kilned. Consequently, the supervisors of the Kootenai and St. Joe Forests were requested to collect some additional samples. As a result, on November 12 Supervisor Fitting of the St. Joe Forest shipped to the Rudoph Wurlitzer Company four carefully selected bolts of Engelmann spruce wood.

With the thought of fostering the lodgepole pine pole industry, Whitney recently furnished the Utah Power & Light Company and the Montana Power Company selected information pertaining to the production, treatment, and use of lodgepole pine poles. The former company uses several thousand of these poles annually. They are produced by a contractor operating on Forest Service stumpage in the Gallatin National Forest at West Yellowstone, Montana. Also of

considerable magnitude are Forest Service sales of lodgepole pine timber products ultimately reaching the Montana Power Company. This company has not as yet purchased very many poles of lodgepole pine, but during the last 7 years has used some 15,000 power-pole reinforcing stubs of this species, cut in the Lewis and Clark National Forest.

Koehler of the Forest Products Laboratory spent from November 5 to 7 in Missoula studying the possibility of using Douglas-fir bark as a substitute for cork. In company with Wellner of the station he visited the A.C.M. sawmill at Bonner, Montana, where measurements of bark thicknesses of typical logs were made and samples of bark obtained for later investigations at the Laboratory.

FOREST AND RANGE INFLUENCES

EFFECT OF COVER ON CLIMATE

Lake States

Bates has made a start on the analysis of the great mass of data collected between 1935 and 1940 on various phases of the shelterbelt influence study, involving use of both natural and artificial wind barriers. The data may be broken down into the following categories:

1. Wind velocity
   a. Effect of density of barrier.
   b. Effect of height of barrier.
   c. Effect of length of barrier.
   d. Increased effect of barriers in series.
2. Orientation
   a. Effect of standard 12-foot wood barrier (50-percent density) at different latitudes, as measured by continuous evaporation in entire field of influence.
   b. Comparative value of
      (1) north-south orientation
      (2) east-west orientation
3. Conservation of fuel by shelterbelts resulting from wind reduction.
4. Crop yield studies
   a. Small grains
   b. Corn
   c. Cotton

5. Soil moisture studies (Stoeckeler).
   a. Effect of tree belts on available soil moisture at different seasons of the year
      (1) Within tree belts
      (2) On adjoining cropland

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW

Appalachian

Drought Conditions in Southeast. The extensive drought in the southern Appalachians and southeastern states is of unusual interest in connection with Forest Influences studies now in progress on the Coweeta and Bent Creek experimental forests. Streams, wells, and springs are low in spite of the fact that the total annual precipitation deficiency is not particularly great. In some localities the streams and wells are remaining low despite good rains at the beginning of December 1941. The reason is that not only are the ground water tables low, but the field moisture is particularly deficient. Recent rains have been moistening the top soil, but they have not yet begun to satisfy the soil retention storage requirements which must be met before movement to the water table can be expected. On the Bent Creek Experimental Forest small forested drainage areas that have a mean summer flow of 0.50 cubic feet per second per square mile were reduced to a flow of 0.05 cubic feet per second per square mile during the month of October.

The most reasonable explanation of the present condition is that winter storage has been lacking for the two winters of 1939-40 and 1940-41. The summer rainfall which brought up the annual total for both years apparently is less effective in bringing up the ground water tables contributing percolation to base stream flow. Of course, when most of the total rainfall for any monthly period occurs as exceptionally intense storms, then surface storm runoff is excessive and a smaller percentage of the rainfall actually contributes to base stormflow or water storage. Apparently, it is the long winter rains of low intensity which are most effective in building up ground water supplies. In addition, it may be necessary to consider the hypothesis that during the warm summer months moisture retained close to the surface is more likely to be lost by evaporation. Also, actively growing vegetation may utilize more moisture when the supply is abundant and easily available. In any case, it is apparent

that an explanation of the present drought conditions in the Southeast may have to be made not only in terms of storm runoff losses, but also in terms of seasonal precipitation as related to evaporation and transpiration losses.

The difficulties in explaining the present drought emphasize the necessity for keeping a seasonal balance on the water economy of a drainage basin. Such a balance would be of special value to the efficient operation of dual purpose reservoirs used both for storage and flood control. Assurance that soil storage opportunities are particularly large would permit utilization of maximum reservoir storage for industrial and municipal uses. Similarly, when the soil moisture is known to be high and little or no storage remains, reservoirs may be drawn down in anticipation of flood possibilities.

California

The Civilian Public Service Camp for conscientious objectors established on the San Dimas Experimental Forest last June has gradually increased to a strength of 90 men. Splendid results have been obtained through their assistance on a wide variety of projects from the collection and compilation of data and the maintenance of research installations to hand labor jobs.

Several professions and skilled trades are represented and the men have had a diversity of experience that cannot be covered here. As examples, the roster includes two graduate foresters, two mathematics instructors, an English teacher, several clerks, an instrument maker, a watchmaker, a machinist, welders, a blacksmith, a radio repairman, carpenters, and other useful artisans.

Both data collection and analysis crews have been organized. A detailed storm plan similar to a fire plan has been prepared for the guidance of camp men assigned to the operation of streamgaging stations and other installations during storm periods. Those working on analysis will aid in the collection of records, and we are looking forward to a good harvest of accurate data during the coming winter season, accompanied by progress in the interpretation of material already available.

Lysimeters. The chief activity, aside from general maintenance, during the summer was the harvest of the crop of Bromus mollis grown on the various lysimeters. Seed had been sown last October at the rate of 70 pounds per acre and produced an excellent stand on the tanks. One large lysimeter, four medium and

four small ones were left bare as controls. The crop, which matured about June 1, reached an average height of 24 inches with a range of from 4 to 50 inches and had an average density of 60 percent. The grass was harvested early in August. Yields from the 5 milacre lysimeters varied from 8.74 to 18.52 pounds per tank, with an average of 14.94 pounds.

Very little seepage occurred, and high rates of runoff were noted. This was undoubtedly due to the fact that the lysimeters are filled with disturbed soil lacking normal structure, which was kept free of vegetation during a settling period of three seasons prior to the removal of the overfill in the summer of 1940. Lysimeter No. 1 was not planted to grass, as it was felt that a control was needed. Three different figures must be used for annual precipitation due to the fact that the grass crop had to be watered in the early part of the season. For No. 1 the figure is 46.85 inches, for No. 2 to No. 26 inclusive, 47.10 inches, while the total measured rainfall was 46.60 inches.

The five unconfined lysimeters were equipped with runoff catchment troughs, tanks, and recording devices in 1940. Unfortunately all the equipment was not in place so that a complete seasonal record could be obtained. The runoff was somewhat less than that from the large lysimeters.

The total seasonal precipitation affecting the unconfined lysimeters was 47.10 inches.

These lysimeters are 7.5 feet wide by 14.5 feet long and have a surface area of 2.5 milacres. They were constructed as pits 17.5 x 17.5 feet in size with a depth of seven feet. Each pit was filled with the same soil as the large lysimeters. The above mentioned plots were laid out on the surface of these pits and delineated by iron border strips. They were all sown with Bromus mollis at the same time as the large lysimeters and developed a comparable grass cover.

Soil Moisture Studies. Periodic soil moisture distributions determined in two large lysimeters, one bare and the other planted to Bromus mollis, have made it possible to measure evaporation and evapo-transpiration water losses under these two cover conditions through the past year. The same kind of study made in one unconfined lysimeter planted to Bromus mollis provides the opportunity to compare evapo-transpiration losses from confined and unconfined soil blocks. The following table shows how the three lysimeters compare:

	Surf. inches water in 6' soil depth		Total for period Oct.1940-Aug. 1941 (Surface inches)			
	Oct.1940	Aug.1941	Precip.	Runoff	Seepage	Evapo-tr.
Large lysim. 1 (Bare)	19.0	19.4	46.8	37.0	0.6	7.4 1/
" " 22 (Grass)	20.1	15.2	47.1	36.7	0.0	13.5
Unconf. " E (Grass)	13.1	12.4	47.1	35.0 2/	2.0	10.8

1/ Evaporation only.
2/ Record extended back to start of season on basis of large lysimeter runoff data.

These data indicate that the presence of grass resulted in the loss of about six inches more water than was loss by evaporation from the bare soil. At the same time only .3 inch more water entered the soil despite its grass cover and the evapo-transpiration use of stored soil water resulted in no seepage flow as compared with .6 inch seepage from the bare soil tank. Comparing unconfined and large lysimeters under grass cover, it appears that the unconfined lysimeter always had the lower soil water storage, that water loss from it due to evaporation and transpiration was less, and that it produced less runoff and more seepage than did either large lysimeter studied.

Rocky Mountain

The measurement of rainfall interception. In the bi-monthly report for February, 1941, (page 63) the results of a study of rainfall interception in lodgepole pine were summarized; some discrepancies were noted and suggestions were given for a new experimental design which should provide more efficient sampling. Since this discussion appeared, a study employing the new design has been completed with success.

To summarize this experiment, it was desired to sample "net" rainfall on 40 half-plots, arranged in four blocks of five whole plots, with a major cutting treatment applied to each whole plot in each block, and timber stand improvement applied to one-half of each treated plot. A pair of rain gages was assigned to each half-plot: one can to measure "gross" rainfall per storm, and the other for "net" rainfall. At the beginning of measurements, the "net" gage was placed at the first of 12 randomized sites, and was moved to a new site after each storm. The "gross" gage was placed as close as possible to the "net" gage, in any crown opening large enough to obviate interception effects. After 12 storms, the gages

were recirculated in randomized sequence over the same 12 sites, until a total of 24 storms had been recorded. Then the study was terminated, with two storms measured at each site.

In covariance analysis, the treatment and minor treatment effects were adjusted to the average size of storm for the season. For the major treatments these results are shown below, and compared with the 1940 data.

Table 1.--Percentage of rainfall intercepted by lodgepole pine under five cutting treatments

Season	(Virgin) 11,890	6000	4000	2000	0
1940	28.6	11.5	6.8	10.3	8.5
1941	32.6	18.0	15.9	15.6	9.5

The 1940 data showed only that any cutting to leave 6000 board feet or less was associated with a substantial reduction in interception. From the new results, however, it can be concluded with fair safety that interception is in approximately linear proportion to intensity of treatment; especially since the standard error of each treatment average was found to be only about 3 percent of the average net rainfall. Incidentally, no significant effect of timber stand improvement on net rainfall could be demonstrated.

With the design employed in the 1941 study it was possible to evaluate errors of sampling, and to partition them into components associated with storm variability and with variation between sites in any plot. For single storms it was found that the interaction of blocks with major treatments (including sampling errors) amounted to 0.0053 inch (standard deviation - 0.073 inch); the sampling variance between sites (within plots) was 0.0044 inch; and the variance in net rainfall between storms at the same site was 0.0027 inch (all adjusted to a uniform size of storm). From these data, the standard deviation of a single storm observation at a single site was 0.052 inch, and at any site in a single plot it was 0.060 inch. Most of the experimental error (inter-action) was composed of sampling errors, which are attributable largely to the "storm" component.

Southwestern

Influence of forests on streamflow. That depth of subsoils and pervious substrata underlying the topsoil mantle have a marked influence on run-off was indicated by the behavior of certain semi-permanent streams on the Sierra Ancha Experimental Forest during the past year.

Two of the principal rock formations on the west face of Sierra Ancha are quartzite and diabase. Where quartzite occurs, soils are generally shallow and underlain by solid bedrock. This is especially true of bench areas where the covering of residual soil is seldom more than 12 inches in thickness and bedrock is usually found at a depth of 3 or 4 feet. Much of the space between topsoil and underlying bedrock is occupied by shattered rock. Where this condition exists, a very high percentage of winter precipitation, falling at a time when both topsoil mantle and shattered rock substratum are already well soaked by previous storms, quickly reaches some drainage channel.

Diabase occurs as a sill overlying the Dripping Springs quartzite which forms the bench below the Parker Creek Station. It is exposed in several low ridges west and south of the station. Diabase has no continuous bedrock such as is found in the quartzite formation. In places large boulders or ledges of considerable extent do occur. However, the depth of pervious soils and soil-forming materials on the diabase ridges in general is much greater than in the quartzite formation. The presence of small, permanent seep springs at various points along the contact line between diabase and quartzite indicates deep penetration of water within the diabase. Exposures of soils and substrata in cut banks along the highway which crosses several of the low diabase ridges reveal great depth of pervious material at some points. In other places impervious substratum lies near the surface.

In winters of below-average precipitation a very large proportion of the precipitation is held by the mantle of soils and underlying pervious substrata in the diabase. With the exception of some surface run-off from areas depleted of vegetation, there is apparently very little yield from the diabase formation.

In the quartzite areas flow is always in evidence for a considerable period in winter, even on years of low precipitation, as the topsoil and shattered rock have only a limited water-holding capacity. Rainfall in excess of this capacity percolates from the top mantle and reaches drainage channels.

In years of normal winter precipitation the water-holding capacity of the pervious mantle of the diabase formation is also exceeded. During years of exceptional winter rainfall, such as for the period October 1, 1940. to May 31, 1941, when 38.29 inches were recorded at the Parker Creek Station, deep deposits are saturated and act as underground reservoirs. In certain small drainageways where clear water flowhad not been previously observed, flow for a considerable period was noted this past winter. In some cases flow which began in March carried through to the summer period. Flow in seep springs along the contact between the diabase and quartzite is now much stronger than usual.

Flow from drainages on the quartzite bench behaved very much as usual, excepting that percentage of yield from the winter's precipitation was much higher than on years of average precipitation. After the winter rains were over percolation continued for a time but ceased in the spring as usual when the free water in the pervious mantle had drained out.

Studies of percolation flow from lysimeters of different depths also indicate that the depth of the pervious mantle above bedrock or impervious substrata definitely affects the subsurface flow and yield of water from an area. At the Parker Creek Station percolation yield has been obtained each winter from lysimeters which are 22 inches and 28 inches in depth. In contrast, percolation is obtained from lysimeters 8 feet in depth only during winter periods when precipitation is considerably above normal, as in the 1936-37 and 1940-41 periods.

On drainage basins of appreciable size the mantle of soils and pervious materials is deeper in some parts than in other parts, hence subsurface flow will be yielded from some areas (where the pervious mantle is shallow) even when winter precipitation is below average, from most areas when precipitation is up to normal, and from practically all areas within the basin when precipitation is exceptionally high. This is one of the reasons why the percentage of yield was so high during the 1940-41 period.

ARTIFICIAL REVEGETATION

Intermountain

Species

A Tetraploid Variety of Agropyron spicatum. The December 1940 bi-monthly report (page 85) contained a note on a new giant form of bluebunch wheatgrass (Agropyron spicatum) under observation at the Paradise Valley Substation in Humboldt County, Nevada.

Since that date there has been an opportunity to have a cytological study made of greenhouse-grown material transplanted from the field. Chromosome counts of mitotic figures in root tip sections have been made by Mr. Lloyd Weaver of Osborn Botanical Laboratory, Yale University, who found 28 instead of the normal complement of 14.*

A more detailed set of comparative measurements has also been prepared from living plants of typical Agropyron spicatum and the larger variety in situ.

The following table contains field measurements of gross characters of selected plants from the same community in addition to comparable size limits taken from Hitchcock's Manual of Grasses.

Character	Normal variety	Giant variety	Hitchcock
Av. height of culms, cm.	60	120	60-100
Av. leaf width, mm.	2.8	7.0	1-4
Length of spike, range, cm.	5-18	10-25	8-15
Av. length of spiklet, mm.	16.8	23.6	15-20
" " " leaf, cm.	16.5	34.5	-
Diameter of bunches, range cm.	15-30	8-74	-
Dry weight of herbage plants of 6 in. diameter, gm.	35	77	-
Percentage germination, 1941	4	0	-
Somatic chromosome number	14*	28	-

*USDA Yearbook, 1937, p. 1094

Although statistical comparison of these measurements has not been attempted, they were taken in a manner to insure freedom from bias and are thought to represent truly the characteristics of the forms. Natural tetraploidy is evidently the cause of giganticism in this new variety of wheatgrass.

There exists the bare possibility that this giant variety is a hybrid resulting from the crossing of Agropyron repens (2n=42) and Agropyron spicatum (2n=14) since the former species is of common occurrence in irrigated meadows of the region. This possibility can be largely discounted owing to the absence of characters common to Agropyron repens. Rhizomes, though present, are relatively no better compared with the typical form, than are other organs.

During the two seasons past, the plants have cast no viable seed. However, the wide variation in diameter of bunches may be taken as evidence of difference in age and that some reproduction has occurred since the chromosome duplication took place.

While the tetraploid excels in production of dry matter, nothing definite can be said in favor of it as a plant for artificial range reseeding until seed production has been stimulated and palatability tested.

Northern Rocky Mountain

Species

Range adaptation tests were established on a Judith Basin and on a Bitterroot Valley area in the fall of 1940 or early in the spring of 1941 and 17 or more species and varieties were planted, either alone or in various mixtures, at each place. Examinations made in October 1941 show 12 species or varieties that promised a medium or better stand at both places under weather conditions that were not particularly favorable through last spring. Several species looked promising on one of these test areas but not on the other, but the following five were encouraging at both areas: Agropyron cristatum (both standard and Fairway varieties), Agropyron inerme, Bromus inerme (both smooth and Parkland strains), Bromus erectus, and Tall oatgrass (Arrhenatherum elatius). The present picture may be quite different when results for another year are available to determine whether any of the other species will be in the contest.

Intermountain

Spring-Fall Range

An extension of range for blue grama. In 1934 during the range survey of the U. S. Sheep Experiment Station range a clump or two of blue grama (Bouteloua gracilis), was discovered. The plant locations were not noted definitely and it remained to an accidental fire covering approximately 3,000 acres of native range during the summer of 1939 to bring to light the fact that an extension of reported range for blue grama had occurred. During the fall of 1939 a single clump of blue grama was discovered, conspicuous on the burned area by virtue of its vigorous regrowth after fall rains. Two other clumps were found during the summer of 1940. The locations of these newly found plants are all about 4 miles from the 1934 site; both sites are 4 miles from traveled roads, 3 miles from abandoned farm land, and 10 miles from any land now farmed.

A careful literature review and correspondence with state and Federal agencies in Idaho and neighboring states indicate that this is probably the first reported collection of blue grama in Idaho. The nearest reported collections are 60 miles north of Dubois, near Dillon, Montana which is across the Continental Divide.

Blue grama is a dominant on the shortgrass plains where the peak of precipitation occurs in summer and most of the plant growth is made during the warm rainy period.

Bluebunch wheatgrass (Agropyron spicatum), the principal grass species at Dubois, commences spring growth about April 1, height growth is completed about the middle of June and seed is matured by the first part of July when available soil moisture has been exhausted. Plants remain dormant during July, August, and September and commence regrowth about the first of October with the advent of fall rains. The blue grama plants at Dubois commence spring growth, complete their height growth, and mature seed about one month later than occurs for each respective stage of bluebunch wheatgrass. Following seed maturity blue grama has a short dormant period and commences fall regrowth in response to autumn rains about the same time as bluebunch wheatgrass. In 1939, early fall rains and warm growing weather caused blue grama to produce seed heads by early November of that year.

During the summer of 1940 the plants produced an abundance of flower stalks. Two spikes were collected on August 4, 1940 from which 50 good seeds were obtained. The germination percentage of these 50 seeds was 92 percent.

The blue grama plants found were rather vigorous in appearance, and appear adapted to the site. There is, however, a lack of any reproduction around the clumps indicating perhaps that, even though viable seed was produced, competition by better adapted species had been too severe to permit survival of the grama seedlings.

Sampling composition of range forages. Little information is available relating to the size and number of herbage samples needed for sampling the chemical composition of range forages.

In connection with forage inventories by the weight-estimate method at the U. S. Sheep Experiment Station it has been the custom to gather at random 5 samples from within a rod-square area of the herbage of the major plant species at each forage inventory date to be used for the determination of moisture content. The samples were air-dried and sent to the University of Idaho where they were composited for each date for chemical analysis. In 1940, however, the samples for arrowleaf balsamroot and bluebunch wheatgrass were not composited, but were analyzed individually for protein, calcium, and phosphorus, the objective being to determine the efficacy of sampling for chemical composition.

Assuming a sampling error of 5 percent of the mean to be satisfactory, satisfactory accuracy for the season as a whole has been secured except for balsamroot phosphorus and calcium. Excellent accuracy was secured in sampling moisture content.

Division of the samples into groups gathered in May and those gathered in June, indicates that protein, phosphorus, and moisture content are much more variable in the last month of the growing season than they are during the first month. This is more pronounced for balsamroot than it is for wheatgrass, which may be indicative of a similar trend with weeds and grasses. This increased variability only means that slightly more samples, or larger samples, on a dry-weight basis, will need to be collected as plant maturity nears.

On the basis of these data it might be recommended, for sampling sagebrush-grass range pastures, that 5 samples be gathered at random from a pasture. These samples should vary in size from 320 and 160 grams at the beginning of the spring season to 210 and 115 grams at the end of the spring season, respectively, for balsamroot and wheatgrass. The 5 samples from each area might be composited for chemical analysis unless it is desired to check on accuracy of sampling.

If each sample were composed of plants collected at intervals, for example every 20 steps, then the accuracy would be much higher than achieved when it was necessary to collect the sample within a rod-square area as was done in this study. Thus, the size of the sample might be much reduced through a more efficient method of sampling.

Northern Rocky Mountain

Shortgrass Ranges

The steady uptrend in density of drought depleted ranges at Miles City that has been evident since 1937 continued into 1941 but at a reduced rate. All perennial grasses combined showed an increase in spring chartings of 3 percent over the 1940 density. Blue grama, bluestem wheatgrass, and needle-and-thread grass increased, ranging from 6 to 24 percent, while buffalo, niggerwool sedge, and Sandberg bluegrass declined from 2 to 12 percent. The total for all vegetation on the quadrats increased 14 percent between 1940 and 1941, but this total increase was made up largely of annual grasses.

Precipitation during late summer of 1940 and the winter and early part of 1941 was generally a little below normal. Doubtless this situation is reflected in the decrease of some and the comparatively slight increase of other perennial grasses. After a slow start on precipitation, 1941 promises to be among the wettest six or seven in 63 years at Miles City. September precipitation was within 0.25 inch of reaching the previous record for that month and the total for October was far above normal. Results of this wet fall on density, particularly on the late developing species such as grama and buffalo grass, should be reflected in chartings to be made in 1942.

The good forage crop was reflected in the heaviest weaning calves that have been produced since this experiment started in 1933. Averages for 1941 were as follows:

Heavily grazed ranges	407.5 pounds
Moderately grazed ranges	453.9 "
Lightly grazed ranges	461.7 "

When total calf weights for 8 years are prorated to all cows in each herd - both wet and dry - the averages are as follows:

Heavily grazed	249 pounds per cow
Moderately grazed	302 " " "
Lightly grazed	294 " " "

At prices of about 11 cents that prevailed the past fall, the 45 and 53-pound advantage in calf production alone on conservately grazed ranges amounts to $5.83 and $4.95 per cow for moderately and lightly grazed ranges. The advantage, when the

extra costs of range plus hay for cattle on heavily grazed ranges are taken into account, is still greater.

Gains of yearling ewes during 1941 were also better than average for the past several years as a result of abnormally abundant green growth through late summer and fall months. Unfortunately, the grazing habits of the sheep, together with the abundant green growth, have tended to obscure effects of degree of grazing on the sheep. All lots gained very uniformly regardless of degree of grazing as shown by the following weight data:

Average gains on heavily grazed pastures			34.6	pounds	per ewe
Average gains on moderately	"	"	34.6	"	" "
Average gains on lightly	"	"	35.1	"	" "

It is evident from past results that weight trends for yearling ewes do not respond to heavy grazing as do cattle. Unfortunately, sheep will not be available to continue this study to further investigate the extent and reasons for this difference. Considering the fact that there is yet little difference in the vegetation on heavily grazed as compared to conservatively grazed cattle pastures, but that vegetation on heavily grazed sheep pastures has been severely damaged, the contrast and the reasons therefor are matters of great importance in range management.

Pacific Northwest

The growing season (May 1-September 30) of 1941 on the Starkey Experimental Range will be long remembered. Records from Ukiah, the nearest weather station to the range showed 1941 to be the wettest May, July, and August, the third wettest June, and the fourth wettest September since 1926. All told, the 13.84 inches precipitation for this 5-month period in 1941 exceeded the 16-year average by 230 percent. Four times as much rain fell in August as had ever been recorded.

The effects of this superabundant summer rainfall in a country where drought is the rule rather than the exception (11 of the past 16 summers have been below average) were very marked. Springs appeared and flowed all summer on flats where no moisture other than surface run-off had been known to collect before. Flats and gentle slopes that previously had been considered to be grassland showed an abundance of bentgrass, creeping red fescue, juncus, and other plants characteristic of meadows. Poa vaseyochloa and, to some extent, Sandberg's bluegrass cured and set seed in standing water. Bluebunch wheatgrass, Idaho fescue, and junegrass (Koeleria cristata) stayed green all summer even in the driest situations.

The growth and use of Sandberg's bluegrass was particularly outstanding. Cured before the grazing season began, this species which makes up 90 percent of the grass herbage was utilized less than 10 percent during the summer. Bluebunch wheatgrass and Idaho fescue stayed green throughout the season and were used heavily and continuously until the cattle were removed in October. Early in the grazing season while there was an abundance of these two species and other succulent feed, cattle were sleek and in good flesh. However, after August 15, cattle lost flesh and condition despite the abundance of cured Sandberg's bluegrass herbage and despite the remarkable fall regrowth that this species produced.

Thus Sandberg's bluegrass, which is able to escape serious damage from drought and overgrazing by virtue of its early maturity and is thereby well-equipped to invade bluebunch wheatgrass-Idaho fescue range, is a double-barreled threat. Not only will it take over such ranges when these conditions persist, but once established in quantity it works to the disadvantage of wheatgrass and fescue reestablishment even in wet years. Control of weakened bunchgrass summer ranges used by cattle is vital if the climax bunchgrass are to be reestablished under a reasonable degree of use.

Rocky Mountain

Summer Range

Good sheep management increases income. Studies of management practices employed by woolgrowers using national forest allotments infested with orange sneezeweed (Helenium hoopesii, A. Gray) indicate clearly that proper management will reduce losses and increase income.

One of the bands of sheep studied on the Uncompahgre National Forest grazed on allotment where heavy sneezeweed infestations were present for three consecutive years. Management practices were poor in 1939, i.e., bedgrounds were poorly distributed and used many times, sheep were not allowed to graze openly and evenly, sneezeweed areas were heavily grazed, etc. Management was improved in 1940, and further improved in 1941, resulting in open herding, uniform utilization, many one-night bedgrounds, avoidance of sneezewood areas when sheep were hungry, and light use of depleted areas.

The death losses incurred are expressed in the following table:

Year	Management	Number	Percent	Number based on 1000 ewes with 1000 lambs
1939	Poor	159	8.68	174
1940	Fair	102	4.90	98
1941	Good	40	2.07	41

The average lamb weights and gross incomes from lambs for the three years are indicated below, using equal prices and equal initial lamb crops.

Year	Lamb weights	Gross income
1939	66.8	$5,871.72
1940	67.1	6,287.27
1941	76.5	7,512.30

A much greater increase in gross income due to good management would be evident if wool crops and lambing percentages were included.

Practically no increase in operating expenses was involved when the owner of this study band of sheep changed from poor to good management.

Short-grass Ranges

Forage composition influences weight gains of cattle.--Analysis of data from 12 experimental pastures on the Central Plains Experimental Range is indicating more and more the importance of weeds, shrubs, and secondary grasses in regulating weight gains of cattle. Differences of 35 to 60 pounds per animal between pastures, not due to variations in grazing intensity, were observed in 1941. These differences were also not explainable on the basis of pasture locations (block differences in the experimental design) or effect of feeding during the winter.

Ordinarily on eastern Colorado short-grass ranges, blue grama and buffalograss furnish from 80 to 98 percent of the forage. The remaining forage is provided by various species which are less abundant and sometimes sporadic in occurrence. Of these secondary species the principal grasses are bluestem wheatgrass, red-three-awn, and desert saltgrass. The weeds of greatest abundance and which are grazed during the first part of the season are Russian thistle, globe mallow, tansy aster, lambsquarter, and pepper grass. The only outstanding shrub so far as utilization by cattle is concerned is four-wing saltbush.

Analysis of data from the experimental pastures by the covariance method indicates a significant correlation between the percentage of the above mentioned secondary species and the total seasonal weight gains of cattle. Cattle grazing native grama and buffalograss pastures in which weeds or shrubs are present have consistently shown better gains than those in pastures where the grass stands are nearly pure. Apparently the relatively small amount of forage provided by these secondary species balances possible nutrient deficiencies that may occur when the diet is almost exclusively grama and buffalograss.

The rancher should keep in mind that two kinds of weed populations may appear on his pastures: (1) The population composed largely of perennial weeds which remain year after year and fluctuates in luxuriance with variations in rainfall; and (2) the population consisting principally of annual species which dominate in wet years and nearly disappear in dry years. The latter generally are indicators of overgrazing, while the former are normal components of the vegetation and indicate conservative use and a desirable range condition.

The results of this study indicate that abandoned fields which have a good cover of vegetation can profitably be grazed simultaneously with adjoining native blue grama range; the swales and meadows characterized by desert saltgrass, sedges, and alkali sacaton can be used to better advantage if they are included in the same pasture with the native shortgrass species, provided these meadows are not needed for winter forage; and that if the range is managed to perpetuate these secondary species there is little need to worry that the short-grasses will suffer from excessive use.

Growth period of blue grama is limited. Clipping studies at the Central Plains Experimental Range indicate that the growth period of blue grama is confined largely to May and June. The production of flower stalks in early July adds somewhat to the total forage weight, but this is not deemed especially important when considering grazing capacity of the range. At no time during the summer of 1941 did the forage become dry, indicating that moisture need not always be the factor limiting the growth period of grama. If results of the future support these findings the stockman may be enabled to make a seasonal adjustment of the stocking rate of his range sufficiently early to utilize the feed available without waste of forage or abuse of the range.

Southwestern

A utilization survey by the line-interception method is based primarily on a measured sample comprised of the measurement

of all perennial grasses encountered on randomly located transect lines of a prescribed length. In addition to the usual linear measurement of basal area, that portion of each grass tuft intercepted by the line is also measured for stubble height. Because of the great variation in grazed heights and in order to simplify compilations and analysis, the stubble is separated into height classes. Measurements of basal area are recorded separately for each stubble-height class.

The field record sheet is a letter-size form especially designed for use in recording data obtained on the individual sampling unit in the field. The field sheets and the pasture summary sheets are almost identical in their make-up. With the addition of two columns for weeds and browse on the right-hand side of the sheet, the form used in presenting the following summary of a pasture survey would also serve as an example of the field record sheet:

Summary of 1941 Utilization Survey Based on 16 Sampling Units
Each Unit Comprised of a Line 100 Feet Long
(Perennial Grass Cover 1.333 Percent)

Species	Per-cent com-posi-tion	Stubble-Height Classes: 1	2	3	4	5	6	7	8	9
		Class intervals: 0-½"	½"-1"	1"-2"	2"-4"	4"-6"	6"-8"	8-10"	10"+	Ungrazed
		Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Aristida divaricata	2.15			18.60	2.33	6.98			5.81	66.28
Aristida glabrata	3.73	6.71	6.71	11.41	30.20					44.97
Bouteloua chondrosioides	2.75	3.63	22.73	32.73	40.91					--
Bouteloua curtipendula	7.83		16.93	49.84	5.43					27.80
Bouteloua eriopoda	11.73	0.64	8.10	19.83	8.32	0.85			1.71	60.55
Bouteloua hirsuta	3.00			27.50	2.50					70.00
Bouteloua rothrockii	18.01	1.11	5.42	12.78	6.39	0.83				73.47
Hilaria belangeri	36.57		2.94	6.50	88.99					1.57
Muhlenbergia porteri	4.53			6.63	21.55	4.97		16.57		50.28
Sporobolus cryptandrus	2.00			7.50	13.75	12.50				66.25
Setaria macrostachya	2.20		27.27	52.27	12.50	7.96				--
Trichachne californica	2.90			20.69	13.79	12.07	10.35			43.10
Other grasses	2.60			3.85	19.23	7.69				69.23
Mean percent stubble height		0.63	5.80	15.76	39.89	1.60	0.30	0.75	0.33	34.94

The foregoing summary presents in a highly condensed form the essential information for the regulation or adjustment of grazing use. For example, all perennial grasses that contribute to the total of this class of vegetation are listed, and the measured percentage composition of each species is stated. In the survey at hand, all species contributing less than 2 percent were grouped under the caption of "Other grasses."

Some of the principal advantages of the line-interception method are:

1. Surveys made by the line-interception method present a picture of grazing use in terms of the amount of forage left on the ground at the close of the grazing year.

2. The survey is based on measured samples randomly selected which may be analyzed and tested by statistical methods.

3. Each grass has an equal and independent chance of being represented according to its relative importance in the total perennial grass stand.

4. Density is based on measurements of the ground actually occupied completely by grasses to the exclusion of other plants. The composition percent is computed from density measurements. Subjective influences such as height, color, etc., are eliminated.

5. Estimates of the degree of grazing use are based on measured stubble height of perennial grasses.

6. Data for each species are listed separately, and the distribution of grazing use within each stubble-height class can be read direct from the compact table.

7. A consistent basis may be maintained for comparisons between surveys of different areas and between the same area for different years.

8. With a good knowledge of how much the principal forage species or the pasture as a whole are being used, stocking may be regulated on a sound basis.

9. No essential information provided by any other commonly used utilization survey method is neglected or eliminated when the line-interception method is employed.

BIOLOGY

(In cooperation with Fish and Wildlife Service)

Lake States

Snowshoe Hare Repellant Studies. Snowshoe hares do heavy damage to young forest plantations in the Lake States, especially when populations are near or at a peak of the cycle. To work out a means of reducing this damage, S. E. Aldous of the Fish and Wildlife Service is aiding in setting up experiments conducted in cooperation with the Nicolet Forest in which various repellants are used on red pine trees in rabbit-tight enclosures which were stocked with a known number of snowshoe hares. Periodic counts are now being made to ascertain how long the repellants are effective and the time of maximum damage to treated and untreated trees.

ENTOMOLOGY

(In cooperation with the Bureau of Entomology and Plant Quarantine)

Appalachian

Bark beetles. An inspection of two 10-year-old small pine plantations at Canton, N. C. disclosed a severe infestation of Ips calligraphus Germ. in the larger trees. The most likely trees were subjected to attack by hordes of beetles emerging from pine bolts in a huge wood storage yard nearby. Although the foliage of the trees appeared normal, the severity of the infestation precluded their survival so most of them were felled and burned. Virginia scrub pine was most heavily attacked, shortleaf pine to a lesser degree, whereas only a few pitch tubes were noted in the white pine.

Northeastern

Decrease in eastern spruce bark beetle. T. J. Parr of the New Haven, Conn. laboratory reports that a survey of spruce areas on the White Mountain National Forest in New Hampshire and the Green Mountain National Forest in Vermont indicated a decrease in incidence of attack by the eastern spruce bark beetle (Dendroctonus

piceaperda Hopk.). This was particularly true on two areas in New Hampshire where control was practiced during the winter of 1940-41. On these areas, over 400 infested trees were removed or cut and burned on about 600 acres of virgin timber. Examination of all spruce trees on a permanent sample strip three chains wide and 180 chains long in the Middlebury District of the Green Mountain National Forest in Vermont showed an infestation of 0.111 tree per acre in October 1941 as compared to 0.203 tree per acre in 1940; a decrease of 0.092 infested tree per acre.

PATHOLOGY

(In cooperation with the Bureau of Plant Industry)

Appalachian

Little-leaf of Southern Pine. The following findings provide the most promising leads in the investigation of the cause of little-leaf: (1) the disease is most severe on soils of low productivity from the standpoint of field crops; (2) any factor, such as fire, that is deleterious to the site, increases the amount of little-leaf; (3) the rate of water infiltration through the A horizon of the soils sustaining healthy shortleaf pine was 7 times as rapid as through the A horizon of comparable soils sustaining little-leaf stands; (4) sclerotia of the fungus known as tuckahoe, or Indian bread, were found on the roots of 17 out of 20 diseased trees and on no healthy trees; (5) accentuated corky-bark formation on the roots of diseased trees seems to greatly reduce the amount of root bark tissue available for food storage; (6) nitrogenous fertilizers slightly improved the appearance of little-leaf trees a few months after application, while phosphate, potash, and several minor elements had no obvious effect at that time.

Oak Heart Rot. Three manuscripts have been submitted to the Journal of Forestry covering the examinations, over a 5-year period, of the oak sprout decay work in progress in northwestern Virginia. The following factors had little effect upon the amount of sprouting: stump height, season of cutting, presence of butt rot when cut, and the occurrence of fire immediately after logging. The sprouts that arise lowest on the parent stump are least likely to develop butt rot. Sprouts of satisfactory low origin followed cutting of very low stumps and also followed burning after clear cutting. Sprouts that arose high on the stumps had a marked tendency to become the dominants within a clump.

Following cutting one of a pair of twin oaks, at the end of 5 years 27 percent of the wounds from 1.0 to 2.5 inches wide had closed, 5 percent of those from 2.6 to 4.0 inches had closed, and none larger had closed. It generally took 4 years for wounds 5.6 inches wide or wider to get back to their size when formed, because of die-back of the bark.

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